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NATIONAL COMMUNICATIONS

COMMUNICATIONS FROM PARTIES INCLUDED IN ANNEX I TO THE CONVENTION: GUIDELINES, SCHEDULE AND PROCESS FOR CONSIDERATION

Possible revisions to the guidelines for the preparation of national communications by Parties included in Annex I to the Convention

Addendum

METHODOLOGICAL ISSUES

Note by the secretariat

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I. INTRODUCTION

A. Mandate

1. The Conference of the Parties, at its first session (COP 1), decided that the Subsidiary Body for Scientific and Technological Advice (SBSTA) should consider the methodological issues arising from the review of national communications, including those identified in the compilation and synthesis of national communications and in available in-depth review reports, and make recommendations thereon to the COP at its second session (decision 4/CP.1).[1] The COP further decided that the SBSTA should provide advice to the COP and to the Subsidiary Body for Implementation (SBI) on further development, refinement, improvement and use of comparable methodologies for national inventories of emissions and removals of greenhouse gases and for projecting national emissions and removals of greenhouse gases and comparing the respective contributions of different gases to climate change.

2. The SBSTA, at its first session, considered the allocation and control of emissions from international bunker fuels, and requested the secretariat to provide an options paper on that subject to the SBSTA for consideration at a future session (FCCC/SBSTA/1995/3).

3. The SBSTA, at its second session, requested the secretariat to prepare a report suggesting possible revisions to the guidelines for the preparation of first communications by Annex I Parties (FCCC/SBSTA/1996/3), taking into account the submissions by Parties and the experience from the review process, for consideration at its third session, aiming at adopting revised guidelines at COP 2 in time for the preparation of the second national communications by Annex I Parties. The SBSTA, with a view to overcoming inconsistencies in the presentation of data on inventories, further requested the secretariat to address issues such as electricity trade, bunker fuels, use of global warming potentials (GWPs), land-use change and forestry, and temperature adjustments in the documentation to be prepared for consideration by the SBSTA at its third session.

B. Scope of the note

4. This document is an addendum to the secretariat's proposal for revised guidelines for the preparation of national communications by Annex I Parties (FCCC/SBSTA/1996/9). It should be read in conjunction with that document and with the second compilation and synthesis of national communications (FCCC/CP/1996/12 and Add. 1 and 2). It should also be read in conjunction with the submissions of the seven Parties that commented on potential revisions to the guidelines for the preparation of national communications by Annex I Parties (FCCC/SBSTA/1996/MISC. 4).

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[1] For decisions adopted by the Conference of the Parties at its first session, see document FCCC/CP/1995/7/Add.1.

5. The present note includes separate sections pertaining to methodological issues in the following areas: accounting for the emissions associated with electricity trade, allocation and control of emissions from marine bunker and aviation fuels, use of GWPs, land-use change and forestry, and the use of temperature adjustments. It also includes options for consideration and suggestions for possible action by the SBSTA. The note is accompanied by a companion document (FCCC/SBSTA/1996/9/Add.2) that contains additional information on the electricity trade and bunker issues.

6. The basic assumption in drafting this note has been that the allocation of emissions should be done in a transparent and comparable way, avoiding double counting or incomplete accounting of emissions. The secretariat recognized that Parties, in the context of their evaluation of policies and measures for their national planning, may need special accounting methodologies. It has been assumed that such needs may best be met by parallel Party-specific accounting, in addition to an agreed common methodology. The SBSTA is invited to consider this assumption and to confirm it.

C. Possible action by the Subsidiary Body for Scientific and Technological Advice

7. The SBSTA may wish to consider several actions related to issues referred to in this note such as:

(a) Making recommendations to the COP, in cooperation with the SBI, regarding the reporting of emissions, and in this context, *inter alia*, confirm, modify or reject the assumption in paragraph 6 above; or

(b) Deferring the consideration of the issues to a future session and requesting Parties to submit comments on this subject; and/or

(c) Requesting Parties, as an interim step, to provide the supplementary information based on one or more of the sections in this note as part of their national inventories due in April 1997;

(d) Advising the Ad Hoc Group on the Berlin Mandate (AGBM) and the SBI to consider the implications for their own work;

(e) Requesting the secretariat to analyse the issues further.

8. Any definitive conclusions resulting from this note would have to be reflected in the recommendations to the COP concerning revisions to the guidelines for the preparation of national communications (FCCC/SBSTA/1996/9).

II. ACCOUNTING FOR THE EMISSIONS ASSOCIATED WITH ELECTRICITY TRADE

A. Introduction

9. The primary purpose of this section on electricity trade is to identify preliminary options for allocating the greenhouse gas (GHG) emissions associated with electricity trade. It also provides information on the current extent of trading and on possible future trends, and points to some potential implications of electricity trading (see also FCCC/SBSTA/1996/9/Add.2).

B. Background

10. The Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories suggest that Parties calculate GHG emissions from energy activities using data on the domestic consumption of carbon-based fuels. This methodology presumes that GHG emissions associated with the process of generating electricity will be accounted for by the generating Party by measuring the consumption of fossil fuels associated with generation, regardless of whether or not that generated electricity is consumed domestically or exported. This approach would also apply to projections of emissions.

11. In the first national communications received, there are several alternative examples of how Parties might account for the emissions associated with electricity trade. For example, one Party (Denmark) accounted for its net imports of electricity in 1990 by simulating production of that electricity from available plants within its own borders; another Party (Netherlands) stated that it had accounted for net electricity imports in its 2000 projection without attaching emissions to it, and yet another Party (Switzerland) stated that emissions generated from exported or imported electricity were not taken into account in their projections. In the case of Denmark, the electricity adjustment makes a difference of about 12 per cent in carbon dioxide (CO_2) emissions in 1990.

12. Inconsistent treatment of the emissions associated with electricity exports and imports creates difficulties in comparing GHG inventory information. It may also lead to double counting of emissions by both the generating and consuming Party or the under-reporting of emissions from electricity trade.

C. Extent of electricity trading

13. Electricity is currently exported and imported by many Parties. Recent efforts by many Parties to liberalize their electricity markets and to remove physical barriers to electricity trade could increase the amount of such trade in the future. The extent of existing

electricity trade as well as future trends in electricity trade for the Nordic region of Europe, Western Europe, Eastern and Central Europe, and North America are discussed in document FCCC/SBSTA/1996/9/Add.2.[2] [3]

D. Implications of electricity trading

14. The current trend to deregulate and liberalize the domestic industries in many countries and the likely increase in the extent of international electricity trading will have implications for the structure of the industry and for GHG emissions, precursors of ozone such as nitrogen oxides (NO_x), and for other air pollutants, such as particulates and sulphur dioxide (SO_2), that are hard to predict. It may also have consequences for the role of governments in planning and regulating electricity production. The impacts that will affect emissions will vary between regions and over time. For example, it is likely that this trend will:

(a) Increase the efficiency of generation;

(b) Change the cost structure of the industry and prices to consumers;

(c) Decrease the level of investments in renewable technologies and demand-side management programmes and alter investment patterns in other technologies;

(d) Change the projected retirement dates and utilization rates of many generation facilities.

15. A recent study of deregulation of the market between Denmark, Norway and Sweden suggests that the costs of reducing emissions could be significantly lower if common reduction goals are developed and countries use electricity trading to reach their goals.

E. Options to account for the greenhouse gas emissions associated with electricity trade

16. In the context of the Convention, electricity trade could be viewed as an activity that may best be addressed jointly by the Parties involved. In order to account for emissions associated with the export or import of electricity two options can be considered, with either

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[2] In the context of this note, the Nordic region refers to Denmark, Finland, Norway, and Sweden. Western Europe refers to Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Portugal, Spain, Switzerland, and the United Kingdom of Great Britain and Northern Ireland. Eastern and Central Europe consist of Belarus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Russian Federation, Slovakia, and Ukraine. North America refers to Canada, Mexico, and the United States of America.

[3] Other regions in the world, for example, Latin America, also trade electricity. The secretariat is attempting to obtain data on this region and others.

the exporting Party or the importing Party doing the accounting. However, an accurate estimate of the emissions associated with electricity imports only appears feasible on the basis of information obtained from the exporting Party regarding, for example, the actual or average sources of electricity. There does not appear to be an obvious basis for an option whereby the importing country would make a determination of the emissions by itself. Therefore, further consideration is given to a modified set of the two options for the treatment of such emissions, as described below. They include either requesting Parties which generate electricity to account for all emissions, even if the electricity is exported; or requesting Parties which consume electricity to account for the emissions on the basis of information provided by, and in coordination with, the exporting Party.

17. These options, their advantages and disadvantages are discussed in detail in FCCC/SBSTA/1996/9/Add.2. In this regard, the following issues arise for the second of these options:

(a) Should calculations be based on actual sources with marginal emissions, or average sources?

(b) Should calculations be completed, for example, on every trade, monthly for all trades, or annually for all trades?

(c) How should transmission losses and secondary effects of changes to the grid be treated?

(d) How should emissions based on electricity trades between more than two Parties be estimated?

18. Should Parties determine a need for supplementary information to be included as part of their national inventories due in April 1997, as identified in paragraph 7 above, they may wish to consider, for example:

(a) A list all of the countries with which they traded electricity physically and contractually in 1994, 1995, and 1996 (both imports and exports);[4]

(b) The quantity of electricity exported or imported from each country in terawatt hours; and

(c) Information on the emissions associated with electricity trade, as available.

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[4] The contractual and physical transfer of electricity internationally may differ, for example, when three Parties are involved.

III. ALLOCATION AND CONTROL OF INTERNATIONAL BUNKER FUELS

A. Introduction

19. The primary purpose of this section is to identify options for the allocation and control of GHG emissions from international bunker fuels. It also provides information on the current extent of such emissions, possible future trends in international aviation and shipping, and issues that should be considered with regard to the options (see also FCCC/SBSTA/1996/9/Add.2).

B. Background

20. The COP, by decision 4/CP.1, requested the SBSTA and the SBI, taking fully into account ongoing work in Governments and international organizations, including the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO), to address the issue of the allocation and control of emissions from international bunker fuels, and report on this work to the Conference at its second session. Subsequently, the SBSTA, at its second session, requested the secretariat to address issues such as bunker fuels in the documentation to be prepared for consideration by the SBSTA at its third session, with a view to overcoming inconsistencies in the presentation of data on inventories (FCCC/SBSTA/1996/8, para. 62).

21. International bunker fuels, that is, fuel sold to any air or marine vessel engaged in international transport is reported separately from other sectors in national emission inventories. The IPCC Guidelines recommend that such emissions should as far as possible be excluded from the totals and subtotals in the energy sector.[5] This reflects the decision of the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (see A/AC.237/55, annex I, para. 1(c)).

22. On this basis, 22 Parties provided emission estimates from bunker fuels, the majority reporting such information separately from total CO_2 emissions in accordance with the guidelines, as indicated in table 1. Eight Parties differentiated between aviation and marine bunker fuel emissions. Five Parties reported only CO_2 emissions from bunker fuels. Of the nine countries with economies in transition, only Bulgaria and Poland reported emissions from bunker fuels and only for their base year (see also FCCC/CP/1996/12/Add.1.).

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[5] IPCC Guidelines for National Greenhouse Gas Inventories, Sections 1A3, 1A3a-i and 1A3b-i provide more detail.

23. CO_2 emissions from bunker fuels represented between 4 and 14 per cent of national CO_2 emissions for the majority of the Parties, although ranging as high as 24 per cent for the Netherlands and as low as less than 1 per cent for the United States of America. Aggregate CO_2 emissions from bunker fuels represent about 2.8 per cent of the national emissions of the 22 Parties reporting emissions.

24. For the majority of the 15 Parties reporting NO_X emissions from bunker fuels these emissions represented between 6 and 26 per cent of national NO_X emissions. Bunker fuel emissions of methane (CH_4), nitrous oxide (N_2O), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC) represented less than one per cent of national emissions for most of the reporting Parties. Data on additional gases may be found in document FCCC/SBSTA/1996/9/Add.2.

25. In addition, the secretariat obtained information from other sources, as reported in FCCC/SBSTA/1996/9/Add.2. These data suggest that in 1990 global bunker CO_2 emissions from the aviation sector were about 435 Mton and from the marine sector about 441 Mton. The emissions in each sector represented about 2 per cent of CO_2 emissions from all sources in 1990.[6]

26. In the future, aviation and marine emissions are likely to grow. National communications provide only limited information on this issue, but the ICAO Committee on Aviation Environmental Protection (CAEP) uses an annual air traffic growth rate of 5 per cent. The resulting effect on emissions will be somewhat less because of improvements in engine efficiency, airframe design and traffic control systems. In the marine sector, the number of cargo vessels and the weight of cargo carried grew each year by 1 and 2 per cent respectively in recent years. This pattern is expected to continue for the foreseeable future, unless world trade is severely disrupted. For the marine sector CO_2 emissions are likely to grow at a rate corresponding to the growth in marine trade, although NO_x emissions may decline as improved technology is introduced in response to concerns over air quality and acidification.

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[6] The percentage of global emissions in 1990 was estimated by using global data for all sources from the IPCC Working Group I report, "Radiative forcing of climate change 1994", and bunker data from Balashov and Smith, "ICAO analyses trends in fuel consumption by world airlines", *ICAO Journal*, August 1992.

Table 1. Anthropogenic emissions of CO_2 and NO_x from international bunkers, 1990 (Gigagrams)[a]

	CO_2			NO_x		
	Aviation	Marine	Total	Aviation	Marine	Total
Australia	4 228.0	2 053.0	6 281.0	16.3	54.4	70.8
Austria	..	..	..	..	..	..
Belgium	..	..	..	..	..	..
Bulgaria[b]	..	..	162	..	..	..
Canada	3 614.0	2 066.0	5 680.0	4.7	13.0	17.7
Czech Republic	..	..	..	..	..	..
Denmark	1 915.0	3 059.0	4 975.0	5.1	66.1	71.1
Estonia	..	..	..	..	..	..
Finland	..	..	2 800.0	..	..	22.0
France	..	..	8 586.0	..	..	110.5
Germany	19 569.0	51.0	155.0	206	..	..
Greece	..	..	11 730.0	..	..	..
Hungary	..	..	..	..	..	..
Iceland	..	..	294.0	..	..	2.5
Ireland	..	..	1 172.0	..	..	5.3
Italy	3 956.6	8 494.0	12 450.0	15.5	234.4	250.0
Japan	..	..	31 000.0	..	..	..
Latvia	..	..	..	..	..	..
Liechtenstein	..	..	..	..	..	..
Luxembourg	..	..	..	..	..	..
Monaco	..	..	..	..	..	..
Netherlands	4 500.0	35 900.0	40 600.0	..	..	..
New Zealand	..	..	2 413.0	..	..	26.9
Norway	300.0	1 500.0	1 800.0	0.7	32.1	32.8
Poland [b]	..	..	530.0	..	..	..
Portugal	..	..	3 938.0	..	..	43.0
Romania	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..
Slovak Republic	..	..	..	..	..	..
Spain	5 948.0	12 076.0	18 024.0	23.6	248.2	271.8
Sweden	..	..	4 190.0	..	..	60.0
Switzerland	..	..	2 160.0	..	..	..
United Kingdom	..	..	20 729.0	..	..	249.0
United States	..	..	82 942.0	..	..	..
Total	..	..	282 026.0	..	..	1 440.1

Notes: The following symbols have been used in some tables:
Two dots (..) indicate that data are not available.
Parentheses ( ) on either side of negative amounts are inserted for clarity.
< Signifies "less than"; > signifies "greater than".

[a] Based on national communications (see FCCC/CP/1996/12/Add.2).

[b] Estimates correspond to the base year (1988).

C. Options for the allocation and control of emissions from international bunker fuels

27. This section elaborates on document A/AC.237/44/Add.2 "Allocation and control of emissions from bunker fuels". It incorporates information provided by Parties and organizations. The implications of the allocation options are discussed in detail in FCCC/SBSTA/1996/9/Add.2 along with the specific characteristics of the aviation and marine sectors. Options that appear to be less practical because of data requirements or because they would not cover all emissions are so identified.

Allocation options for emissions from the use of bunker fuel

Option 1 No allocation, as in the current situation.

Option 2 Allocation of global bunker sales and associated emissions to Parties in proportion to their national emissions.

Option 3 Allocation to Parties according to the country where the bunker fuel is sold.

Option 4 Allocation to Parties according to the nationality of the transporting company, or to the country where a ship of aircraft is registered, or to the country of the operator.

Option 5* Allocation to Parties according to the country of departure or destination of an aircraft or vessel. Alternatively, the emissions related to the journey of an aircraft or vessel could be shared by the country of departure and the country of arrival.

Option 6* Allocation to Parties according to the country of departure or destination of passenger or cargo. Alternatively, the emissions related to the journey of passengers or cargo could be shared by the country of departure and the country of arrival.

Option 7* Allocation to Parties according to the country of origin of passengers or owner of cargo.

Option 8* Allocation to the Party of all emissions generated in its national space.

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* Options considered to be less practical because of data requirements or inadequate global coverage.

Considerations regarding allocation and control

28. The experience gained with allocation methods for emissions from other sectors may be instructive. In the case of road transport, emissions are allocated to the Party where fuel is taken in. For other sectors, such as the cement industry, the emissions are allocated to the Party where emissions actually occur. Finally, there is no sector for which the emissions are calculated and allocated in relation to individual persons or goods.

29. In relation to the allocation options for emissions from bunker fuels, the following questions are relevant:

(a) Would it be feasible for the Party to control the emissions allocated to it?

(b) Could the required data be generated with sufficient precision?

(c) Is the method based on the "polluter pays" principle?

(d) Is the method equitable?

(e) Does the allocation method cover all international emissions?

(f) Is the method suitable for all greenhouse gases?

(g) Should the method apply to both aviation and marine emissions?

(h) Does the method provide a suitable basis for making projections?

30. In addition to the above points, the following factors could be considered:

(a) If international emissions are allocated to Parties, these Parties would need to decide whether and how to develop control measures. This could be in the form of action at the national level and/or at the level of cooperation with other Parties and/or at the international level;

(b) If the Parties decide not to allocate bunker fuel emissions to specific Parties, the international aviation and marine shipping sector will still need to be considered in relation to Article 4.2 of the Convention. In that case, Parties may need to determine whether and how emissions should be controlled. In this respect, ICAO and IMO may be of assistance;

(c) Also the Parties would need to consider whether to apply allocations retrospectively or as of some future date. For instance, the Parties could make a retrospective correction for international emissions from the reference year 1990 or to any

future year. This could affect whether Parties would meet their national goals and may therefore need further consideration by other Convention bodies;

(d) Option 8 would lead to incomplete coverage at the global level, since emissions over international territories would not be allocated.

IV. USE OF GLOBAL WARMING POTENTIALS

A. Introduction

31. A recommendation concerning GWPs may be found in document FCCC/SBSTA/1996/9 on possible revisions to the guidelines for national communications by Annex I Parties. This section provides background information that Parties may wish to consider regarding GWPs. It contains a brief history of the changes in GWPs and the most recent scientific information. It was developed from information provided by the IPCC.

B. Background

32. The guidelines for the preparation of the first communications by Annex I Parties state: "Parties may choose to use GWPs to reflect their inventories and projections in carbon dioxide-equivalent terms using information provided by the IPCC in its 1992 Supplementary Report, pending the decision of COP 1. While awaiting updated information from the IPCC, any use of GWPs should be based on the direct effects of the greenhouse gases over a 100-year time-horizon. In addition, Parties may also make use of at least one other time-horizon and may also include, separately, data incorporating the indirect effects of methane. This is only the initial focus and, for future communications, indirect effects of other greenhouse gases will have to be looked at, as far as scientific understanding allows" (A/AC.237/55, decision 9/2, annex).

33. At COP 1, it was decided that Parties may use GWPs to reflect their inventories and projections in carbon dioxide-equivalent terms. In such cases, the 100-year time-horizon values provided by the IPCC in its 1994 Special Report should be used. Parties may also make use of at least one of the other time horizons provided by the Panel in its 1994 Special Report (FCCC/CP/1995/7/Add.1).

34. In the first 28 national communications of Parties included in Annex I, all Parties reported the emissions of greenhouse gases in standard units of mass. Sixteen Parties expressed their emissions in carbon dioxide-equivalent terms using 1990, 1992 and/or 1994 GWPs, mostly for the 100-year time-horizon.

35. Inconsistent use of GWPs makes it difficult to compare greenhouse gas inventory information.

C. Discussion

36. The GWP is an attempt to provide a simple measure of the relative radiative effects of the emissions of various greenhouse gases. The index is defined as the cumulative radiative forcing between the present and some chosen time horizon caused by a unit mass of gas emitted now, expressed relative to that for some reference gas (here CO_2 is used). The global warming contribution of different GHG emissions can be compared by multiplying the mass of the emissions of a GHG by its GWP to obtain the equivalent mass of carbon dioxide.

37. In the IPCC First Assessment Report 1990, preliminary values for GWPs were given, which attempted to account for direct effects of the greenhouse gases as well as the indirect effects on stratospheric water vapour, carbon dioxide and tropospheric ozone. Gases included were carbon dioxide, methane, nitrous oxide and a range of chlorofluorocarbons (CFCs).

38. The IPCC in its supplementary report to the IPCC Scientific Assessment 1992 stated that the indirect GWP components reported in 1990 were likely to be in error and should not be used. A new set of only direct GWPs was provided. The new direct values were generally within 20 per cent of the values of 1990, the difference being entirely due to the difference in assumed lifetimes. Gases included were carbon dioxide, methane, nitrous oxide and a range of CFCs, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), CO, NMVOCs and NO_x.

39. In the 1994 IPCC report, "Radiative forcing of climate change" new GWP values were published taking account of the direct and indirect effects where possible. The indirect effects of NO_x, and CO and of CFCs associated with the depletion of the ozone layer were not included in the calculations. The number of gases was expanded.

40. Updated GWP values were published in the IPCC Second Assessment Report, 1995. The report notes that net GWPs of CFCs tend to be positive, but no numeric values were given. Decreases of about 10 per cent to 15 per cent in comparison to the values of 1994 are because of improved or new estimates of atmospheric lifetimes and molecular radiative forcing factors, and improved representation of the carbon cycle. Table 2 presents the GWPs as they have changed over time in subsequent IPCC publications.

Table 2. Global warming potentials, 100-year time-horizon, 1992-1995

Gas	1992[a]	1994[b]	1995[c]
CO_2	1	1	1
CH_4	11	24.5	21
N_2O	270	320	310
CFC-11	3400	4000	..
CFC-12	7100	8500	..
CFC-13	13000	11700	..
CFC-14	>4500	..	..
CFC-113	4500	5000	..
CFC-114	7000	9300	..
CFC-115	7000	9300	..
CFC-116	>6200	..	..
HCFC-22	1600	1700	..
HCFC-123	90	23	..
HCFC-124	440	480	..
HCFC-141b	580	630	..
HCFC-142b	1800	2000	..
HCFC-225ca	..	170	..
HCFC-225cb	..	530	..
CCl_4	1300	1400	..
CH_3CCl_3	100	110	..
H-1301	..	6200	..
HFC-23	..	12100	11700
HFC-32	..	580	650
HFC-41	..	..	150
HFC-43-10mee	..	1600	1300
HFC-125	3400	3200	2800
HFC-134	..	1200	1000
HFC-134a	1200	1300	1300
HFC-152a	150	140	140
HFC-143	..	290	300
HFC-143a	3800	4400	3800
HFC-227ea	..	3300	2900
HFC-236fa	..	8000	6300
HFC-245ca	..	610	560
CF_3Br	4900	..	..

Table 2. *(continued)*

Gas	1992[a]	1994[b]	1995[c]
$CHCl_3$	25	5	..
CH_2Cl_2	15	9	..
SF_6	..	24900	23900
CF_4	..	6300	6500
C_2F_6	..	12500	9200
C_3F_8	..	..	7000
C_4F_{10}	..	..	7000
c-C_4F_8	..	9100	8700
C_5F_{12}	..	..	7500
C_6F_{14}	..	6800	7400

Sources: IPCC, "Climate Change 1992", "Climate Change 1994," and the "Second Assessment Report 1995".

Notes:

[a] Only direct effect.
[b] Indirect effects were included where possible, with the exception of CFCs.
[c] Because of the difficulties in calculating the indirect effects of CFCs and halons, no values were included. Net GWPs of CFCs tend to be positive, while net GWPs of halons tend to be negative.

V. ACCOUNTING FOR LAND-USE CHANGE AND FORESTRY

A. Introduction

41. The purpose of this section is to identify the methodological issues associated with estimating and reporting the carbon emitted or sequestered as a result of land-use change and forestry. It also provides data submitted by Parties in their national communications, and discusses the policy significance of different options.

B. Background

42. The IPCC Guidelines for the land-use change and forestry sector provide a methodology, including standard data tables, for reporting on this sector. On this basis, 28 Parties submitted inventory data for 1990. However, only 18 Parties submitted projections for this sector. Several Parties submitting data provided incomplete data sets. In

some cases, this was attributed to a lack of appropriate activity data and statistics. For several countries, updates with substantial changes were provided or indications were given that further changes would be forthcoming.[7]

43. The SBSTA, at its second session, invited Annex I Parties to forward to the secretariat their suggestions related to the presentation of inventory data for years subsequent to 1990 and on projections in this sector, as well as on aggregating data on greenhouse gas sources and sinks by 1 April 1996. The secretariat did not receive any submissions following this invitation. However, some Parties expressed concern, during the review process, regarding the methodologies used to estimate carbon emissions or sinks for the land-use change and forestry sector and others have expressed concern with regard to how sequestered carbon should be presented and reported.

Inventory calculations

44. With regard to the IPCC Guidelines for calculating emissions and sinks, there are uncertainties related to, for example:

(a) Estimates of biomass density and its rate of change in different regions;

(b) Emission factors associated with different types of biomass and land clearing practices;

(c) Methods for estimating the changes in different land-use areas;

(d) Assumptions and methods for estimating the storage of carbon in wood products;

(e) Appropriate period of time for calculating sources and sinks.

Reporting and presentation

45. With regard to reporting and presentation of data on this sector, combined with data from other sectors, Parties have expressed a need for clarification as to how Parties should provide information. Some Parties prefer to subtract the carbon sequestered or stored in sinks from their emissions in other sectors, i.e., they take a "net approach", while others prefer not to add or subtract the data from this sector to the other sectors, but present them in different tables; that is, a "gross approach". These two approaches may be linked to the way Parties have formulated their national goals and can have significant effects on projections of CO_2 in the year 2000, as shown in table 3. The table is based on information submitted by

[7] During the in-depth reviews, Parties noted that the definition of anthropogenic emissions and sinks may need clarification with regard to forest fires and the effect of climate change on growth.

only 18 Parties. The data from five Parties (Austria, Finland, Latvia, New Zealand, Sweden) indicate that carbon dioxide sequestered or emitted from land-use change and forestry amounted to nearly a third of the gross CO_2 emissions from other sectors. Consequently, in the base year small shifts in the figures for carbon stored may have significant impacts, as may be seen in columns 3 and 8 which are two indicators of whether a Party may stabilize emissions.

Table 3. Projections of gross and net anthropogenic emissions of CO_2, after consideration of land-use change and forestry[a] [b] (Gigagrams)

	1990 gross[c]	2000 gross	Variation %	1990 LUCF	2000 LUCF	1990 net[d]	2000 net	Variation %
	(1)	(2)	(3)	(4)	(5)	(6) (= (1)+(4))	(7) (=(2)+(5))	(8)
Australia	288 965	332 799	15.1	130 843	121 992	419 808	454 791	8.3
Bulgaria [e]	96 878	69 878	-27.9	-4 697	< -5 801	77 189	< 64 077	< -17.0
Czech Republic	163 584	135 536	-17.1	-2 300	-2 800	161 284	132 736	-17.7
Denmark	58 353	53 753	-7.9	-2 600	-2 600	55 753	51 153	-8.3
Finland	54 200	70 200	29.5	-31 000(-40 000)	- (-23 000)	23 500	30 200 - 47 200	30.2 to 103.4
France	383 167	397 833	3.8	-32 000	-39 000	351 167	358 833	2.2
Germany	1 014 155	917 000	-9.6	-20 000	-20 000	994 155	897 000	-9.8
Ireland	30 719	36 988	20.4	-5 133	-8 066	25 586	28 922	13.0
Italy	423 776	482 440	13.8	-36 730	-46 730	387 046	435 710	12.6
Japan	1 173 00	1 200 000	2.3	-90 000	-92 000	1 083 000	1 108 000	2.3
Latvia	22 976	16 956	-26.2	-14 000	-8 940	8 976	8 016	-10.7
Netherlands	174 000	167 600	-3.7	-1 500	-1 800	172 500	165 800	-3.9
New Zealand	25 530	29 160 - 29 940	14.2 - 17.2	-17 700	-18 600	7 830	10 560 - 11 340	34.9 to 44.8
Spain	222 908	276 523	24.1	-23 170	-25 700	199 738	250 823	25.6
Sweden	61 300	63 800	4.1	-34 000	-29 000	27 300	34 800	27.5
Switzerland	45 400	43 800	-3.5	-5 200	-5 300	40 200	38 500	-4.2
UK	586 720	586 720	0	-9 167	- -9 157	577 553	577 553	0
USA	5 012 789	5 163 136	3.0	-476 710	-539 049	4 536 079	4 624 087	1.9
Austria	59 900	65 800	9.8	- 15 000	..	44 900	..	..
Canada	461 200	510 000	10.6	..	..	..	..	..
Estonia	37 90	17 500 - 23 000	(-53.7) - (-39.2)	1 796	..	39 596	..	..
Greece	82 : 0	94 500	15.1	..	..	..	..	..
Hungary [e]	81 534	68 741	-17.8	-3 097	..	78 437	..	..
Iceland	2 172	2 282	5.1	..	..	..	..	..
Liechtenstein	208	245	18.1	-22	..	186	..	..
Luxembourg	11 244	7 556	-33.3	..	..	..	..	..
Monaco	..	..	..	..	..	..	..	..
Norway	35 400	39 500	11.2	-10 200	..	25 200	..	..
Poland [e]	478 880	338 000 - 455 000	(-18.59) - (9.7)	1 408	..	477 472	..	..
Portugal	38 689	54 274	28.8	..	..	..	..	..
Romania [e]	198 479	..	..	..	..	195 554	..	..
Russian Federation	2 330 000	1 930 000 - 2 026 000	(-19.1) - (-15.1)	-734 000	..	1 596 000	..	..
Slovakia	57 808	48 639	-16.5	-4 451	..	..	53 357	..

Note: LUCF = land-use change and forestry.

[a] Based on data contained in tables B.1 and B.2 of document FCCC/CP/1996/12/Add.1.

[b] Austria, Canada, Estonia, Greece, Hungary, Iceland, Liechtenstein, Luxembourg, Monaco, Norway, Poland, Portugal, Romania, Russian Federation, and Slovakia did not give projections of the land-use change and forestry sector.

[c] Gross emission = CO_2 emissions from carbon sources excluding land-use change and forestry.

[d] Net emission = Gross CO_2 emission minus CO_2 sequestered or emitted from changes in land-use on forestry.

[e] Some countries with economies in transition use a different base year than 1990: Bulgaria (1988); Hungary (August 1985-1987); Poland (1988); and Romania (1989).

C. Discussion

46. Judging from the in-depth reviews, there is a need to elaborate on the methodologies to calculate emissions and sinks in the land-use change and forestry sectors, particularly with regard to the uncertainties listed above. The IPCC has activities under way to do this, including, for example, developing improved methods to account for emissions from wood products, better data on boreal forests, and an improved classification system for tropical regions. The IPCC will take up several, but not all, proposals for improved methodologies related to this sector at its plenary session in September 1996.

47. With regard to the question of how to report information, there appear to be two options, namely, the "gross" or the "net" approach. In considering this issue, Parties may wish to bear in mind the effects of these two approaches on global forestry actions under Article 4.1(b), as well as the impact on individual Parties (see paragraphs 48 and 49 below). Also, the ability of a Party to meet a target may change with time depending on its circumstances. For example, some Parties that opt for the "net" approach may benefit in the near term by using carbon sinks to offset other emissions. In the long term, as forests mature and reach a steady state of growth, this could mean that a smaller sink would be available and therefore larger reductions in other sectors would be needed to achieve a national goal.

48. The information reported by Finland and Sweden can be used to illustrate how the net approach affects some Parties. The forests in these countries are currently sequestering carbon and will continue to do so in the year 2000. As a result, they reduce the amount of carbon in the atmosphere. In addition, the 1990 figures for net removals of CO_2 are equivalent to more than 50 per cent of their "gross" emissions. This sequestration rate may not necessarily be maintained in 2000 and beyond, since natural processes will lessen the size of the sink. Indeed, this rate of sequestration is generally expected to level off in the future and consequently, when using the "net" approach, achievements towards meeting national goals with regard to the Convention and sustainable forest management practice could be viewed negatively.

49. In contrast, the "gross" approach may be viewed as giving less emphasis to the role of forests and the incentives to encourage good forest management practices. This could have implications for countries seeking to use a comprehensive approach to achieving national goals, along with investments in this sector.

50. Parties may therefore wish to consider whether data should be presented and reported using the "net" or the "gross" approach.

VI. USE OF TEMPERATURE ADJUSTMENTS

A. Introduction

51. The purpose of this section is to provide information for an initial discussion on matters related to the use of temperature adjustments for calculating national GHG inventories. It introduces basic factors needed to calculate temperature adjusted emissions.

B. Background

52. A significant part of the energy consumption in some countries, and hence of emissions of CO_2 and some other GHGs and precursors, stems from the use of energy to heat and cool buildings. In cold winters, the total amount of energy used for heating will be higher than in mild winters. In hot summers, the total amount of energy used for cooling will be higher than in mild summers. These conditions vary between countries and within countries, particularly those with large land areas.

53. The importance of this issue has been noted by several Parties. One Party adjusted its CO_2 emission estimate for 1990 upward to take account of warmer climatic conditions and presented this adjusted figure as the working figure. In addition, it provided the actual emission estimates in its national inventory of anthropogenic emissions and removals for 1990. Several Parties noted that 1990 had not been a normal climatic year, but did not adjust their inventory data. Six Parties provided additional information during the in-depth reviews. When calculating projections of national emissions, three Parties adjusted the starting points for their projections and two gave quantitative indications of what such an adjustment would have meant for them. All these estimated adjustments were in the range of 0-5 per cent.

54. Adjustments by some Parties to their GHG estimates in 1990 or the starting points for their projections, whether to account for unusually mild or cold winters or unusually hot or cool summers, can impair the comparability of GHG estimates among Parties. They can also have effects on a Party's baseline emissions, thereby altering the level of effort necessary for a Party to meet its commitments to reduce GHG emissions. On the other hand, one Party noted that without temperature adjustments, fluctuations between cold and mild seasons could easily lead to inaccurate interpretations of trends in CO_2 emissions and that it would not be clear what fraction of the change in CO_2 emissions would be induced by policy measures, and what fraction would be due to variations in the outside temperature. Another Party indicated that the Convention is explicit in setting a base year and that the complexity of negotiating adjustments is not warranted. Finally, it should be noted that if adjustments were allowed, inventories would not reflect real emissions.

C. Options for the use of temperature adjustments

55. There are two issues that need consideration with regard to temperature adjustments. The first is the method of calculating the adjustments. In this regard, several factors need consideration, for example:

(a) The basis for the adjustment, that is, absolute temperatures or indicators such as "degree days";

(b) The extent to which geography and the location of population centres should be considered;

(c) The time periods to be used;

(d) The fuels to be considered.

56. In addition, there is a need to consider whether and how these factors would affect projections. However, in so far as only one Party has provided temperature-adjusted data,[8] there is little information available to determine how the use of these different factors could affect emissions.

57. The second issue concerns whether and how to report temperature-adjusted emissions. In order to ensure transparency, there appear to be two choices, namely, requesting Parties to provide only data that are not temperature-adjusted or giving those Parties wishing to do so the option of providing supplementary adjusted data along with a description of their method. Other Convention bodies may need to consider how to treat the additional information.

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[8] Five Parties provided estimates.

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NATIONAL COMMUNICATIONS

COMMUNICATIONS FROM PARTIES INCLUDED IN ANNEX I TO THE CONVENTION: GUIDELINES, SCHEDULE AND PROCESS FOR CONSIDERATION

Addendum

DETAILED INFORMATION ON ELECTRICITY TRADE AND INTERNATIONAL BUNKER FUELS

Note by the secretariat

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I. INTRODUCTION

A. Mandate

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its first session, considered the allocation and control of emissions from international bunker fuels, and requested the secretariat to provide it with an options paper on the allocation and control of international bunker fuels for consideration at a future session (FCCC/SBSTA/1995/3). At its second session, with a view to overcoming inconsistencies in the presentation of data on inventories, the SBSTA further requested the secretariat to address issues such as temperature adjustments, electricity trade, bunker fuels, use of global warming potentials, land-use change, and forestry in the documentation to be prepared for consideration by the SBSTA at its third session (FCCC/SBSTA/1996/8).

B. Scope of the note

2. This note is an addendum to the secretariat's proposal for revised guidelines for the preparation of national communications by Annex I Parties (FCCC/SBSTA/1996/9). It should be read in conjunction with document FCCC/SBSTA/1996/9/Add.1 which describes methodological issues and identifies possible action the SBSTA may wish to consider. It provides detailed information on electricity trading and international bunkers to supplement document FCCC/SBSTA/1996/9/Add.1.

3. In preparing this document, the secretariat reviewed data gathered by international organizations such as the United Nations, the Statistical Office of the European Communities (EUROSTAT), the International Energy Agency (IEA), the International Civil Aviation Organization (ICAO), and the International Maritime Organization (IMO). The aviation and marine sector data, in particular, differ among sources, over time, in the number of countries covered, and in methodologies. In this regard, the secretariat has chosen to use data which demonstrate issues associated with particular options, rather than attempt to find data that are completely consistent. Data for non-Annex I countries are presented in some cases for comparative purposes. Also, the secretariat did not undertake a comprehensive analysis of all data. The SBSTA is invited to consider the data needed for the allocation options identified in this note and to provide guidance on this issue.

4. Section III of this document, on emissions from international bunkers, is divided between aviation and marine bunkers, since the structure of the industries is different and hence also the possible allocation and control options that may be selected.

II. ACCOUNTING FOR THE EMISSIONS ASSOCIATED WITH ELECTRICITY TRADE

A. Introduction

5. The primary purpose of this section is to provide detailed information on the extent of trading, together with the implications of and possible options to account for emissions associated with electricity trade. The general background, possible action by the SBSTA and a preliminary discussion of options may be found in document FCCC/SBSTA/1996/9/Add.1.

B. Background information on electricity trade

6. Electricity is currently exported and imported by many countries. In the context of the United Nations Framework Convention on Climate Change (UNFCCC), these electricity trades could be viewed as an activity that may be addressed jointly by the Parties involved. Recent efforts in many countries to liberalize their electricity markets and to remove physical barriers to electricity trade could increase the amount of such trade in the future. The extent of existing electricity trade as well as future trends in electricity trade are described below for the Nordic region of Europe, Western Europe, Eastern and Central Europe, and North America as these regions are currently undergoing the significant change.[1, 2]

Nordic region

7. In 1993, 18 terawatt hours (TWh) of electricity were exchanged between Denmark, Finland, Norway, and Sweden, representing 5 per cent of total generation in these countries. Electricity exchange in the Nordic countries began on a bilateral basis as early as 1915 when the first connection between Denmark and Sweden was established. Denmark, Norway, Sweden, and Finland now trade through Nordel, an association of the major generators responsible for operating the grids, the exchanges being the result of substantial differences in the structure of their capacity and in the variable costs of their electricity.[3] More than 99 per cent of Norway's electricity comes from hydropower; Denmark's system is

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[1] In the context of this note, the Nordic region refers to Denmark, Finland, Norway, and Sweden. Western Europe refers to Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Portugal, Spain, Switzerland, and the United Kingdom of Great Britain and Northern Ireland. Eastern and Central Europe consists of Belarus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Russian Federation, Slovakia, and Ukraine. North America refers to Canada, Mexico, and the United States of America.

[2] Other regions in the world, for example Latin America, also trade electricity. The secretariat is attempting to obtain data on this region and others.

[3] Tomas Larsson, "Benefits from electricity trade in northern Europe under CO_2 constraints," forthcoming in *Systems Modelling for Energy Policy*, Bunn and Larsen (eds.), John Wiley & Sons.

approximately 97 per cent thermal with a heavy dependence on coal; Sweden depends on a mix of hydropower and nuclear power; and Finland depends on a mix of hydropower, nuclear power, and thermal power.[4] The historical pattern has been for Norway and Sweden to export excess power during wet seasons and years, through the utilization of bilateral agreements on the basis of short-run marginal costs,[5] and to import in dry and cold seasons and years. Short-term exports of hydro-based power in peak periods and imports of thermal in off-peak periods are also possible during a 24-hour period. Data on the exports and imports of electricity in the Nordic countries in 1993 are presented in table 1.

Table 1. Bilateral electricity trade flows among the Nordic countries, 1993[a]
(Terawatt hours)

	Exports to					
Exports from	Denmark	Finland	Norway	Sweden	Other[b]	Total
Denmark	..	..	0.19	1.31	3.60	5.10
Finland	..	..	0.01	0.42	..	0.43
Norway	2.14	0.06	..	6.18	..	8.38
Sweden	3.98	3.14	0.51	..	0.51	8.57
Other[b]	0.13	4.77	..	..	..	4.90
Total	6.25	7.97	0.71	7.91	4.11	27.38

Source: International Energy Agency, *Electricity Information 1994*, Paris, 1995.

Notes: The following symbols have been used in some tables:

Two dots (..) indicate that data are not available.
A hyphen (-) indicates that the item is not applicable.
A minus sign (-) before a figure indicates an amount subtracted. Note that the minus sign comes immediately before the number.
A point (.) is used in English to indicate decimals.

[a] Values identify point of entry or exit, but do not necessarily identify point of consumption.
[b] Other refers to Germany and the Russian Federation.

[4] International Energy Agency, *Energy Statistics of OECD Countries*, Paris, 1995.

[5] Larsson, Grohnheit and Unander, *Common Action and Electricity Trade in Northern Europe*, to be presented at the International Federation of Operational Research Societies 14th Triennial Conference, Vancouver, Canada, 8-12 July 1996.

8. Electricity imports and exports between Nordic countries could increase in the near future. Finland, Norway, and Sweden have recently liberalized their electricity markets and Denmark plans to do so. Moreover, several new transmission lines between Nordic countries and other countries are currently planned or under construction: these include grid connections between Germany and Denmark, two cables between Germany and Norway, a cable between the Netherlands and Norway, two cables between Finland and the Baltic States, and a grid connection between Norway and Sweden. [6]

Western Europe

9. In 1993, 136.9 TWh of electricity were exchanged between countries of Western Europe representing 7 per cent of total generation in these countries.[7] Because of the physical and economic structure of the utility systems in Western Europe, as well as the surplus generating capacity in some countries, there are substantial incentives for electricity trade in this region. Currently, France and Switzerland are net exporters to the rest of Western Europe, with Italy and the Netherlands being the largest net importers. Exports from France mostly consist of long-term contracts for excess nuclear capacity, while exports from Switzerland result from excess hydroelectric and nuclear capacity with low variable costs. There are, however, flows in both directions between most neighbouring countries in Western Europe. Data on the exports and imports of electricity in West European countries in 1993 are reported in table 2.

10. The amount of electricity trade in Europe could increase as the European Union moves forward with its plans to liberalize the electricity market although the pace of this process may differ among countries. Energy ministers are discussing a proposal to open up to competition 25 per cent of Europe's electricity market. Competition would begin two years after the passage of legislation by the European Union Council of Energy Ministers and the European Parliament. [8]

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[6] International Energy Agency, Standing Group on Long-Term Co-operation, "Inter-system competition and trade in electricity -- Implications for the environment and environmental policy," IEA/SLT (95)25, draft paper dated 20 November 1995.

[7] International Energy Agency, *Electricity Information 1994*, Paris, 1995.

[8] *International Herald Tribune*, 7 May 1996.

Table 2. Bilateral electricity trade flows among countries of Western Europe, 1993[a]
(Terawatt hours)

	Exports to												
Exports from	Austria	Belgium	France	Germany	Italy	Luxembourg	Netherlands	Portugal	Spain	Switzerland	UK	Other	Total
Austria	..	..	..	3.2	1.7	..	..	..	..	1.3	..	2.5	8.8
Belgium	..	..	1.5	..	..	0.7	3.2	..	..	..	..	..	5.4
France	..	4.4	..	13.7	17.5	0.1	..	..	2.7	9.7	17.0	0.1	65.1
Germany	4.9	..	0.5	..	..	3.7	10.8	..	..	7.9	..	5.1	32.8
Italy	..	..	0.2	..	..	..	..	..	..	0.1	..	0.4	0.7
Luxembourg	..	..	..	0.4	..	..	..	..	..	..	..	..	0.4
Netherlands	..	0.1	..	0.2	..	..	..	..	..	..	..	..	0.3
Portugal	..	..	..	..	..	..	..	..	1.9	..	..	..	1.9
Spain	..	..	1.1	..	..	..	..	2.1	..	..	..	..	3.2
Switzerland	0.6	..	0.7	5.7	19.5	..	..	..	..	..	..	0.2	26.7
UK	..	..	..	..	..	..	..	..	..	..	..	..	0.0
Other	3.3	..	..	8.6	1.4	..	..	..	..	..	..	..	13.2
Total	8.8	4.5	4.0	31.9	40.1	4.4	14.0	2.1	4.6	19.0	17.0	8.3	158.4

Source: International Energy Agency, *Electricity Information 1994*, Paris 1995.

[a] Values identify point of entry or exit, but do not necessarily identify point of consumption.
[b] Others include the Czech Republic, Denmark, Hungary, Poland and the former Yugoslavia.

Central and Eastern Europe

11. The electricity systems of Central and Eastern Europe are strongly interdependent. Those of Belarus, Estonia, Latvia, Lithuania, and the Ukraine were established as part of the unified power system of the former Soviet Union. Power plants were located in this system without consideration of boundaries. Thus, although there has been a substantial reduction in energy demand in this region recently, some Central and Eastern European countries still import electricity, as they rely on capacity located outside their borders.[9]

12. The change in the structure of institutions in Central and Eastern Europe makes it difficult to utilize historical patterns of electricity trade to predict future trends. Some countries are trying to reduce their dependence on traditional sources of electricity. For instance, the Czech Republic, Hungary and Poland, which are currently integrated and synchronized with the Eastern European electricity system, have recently formed an organization, CENTREL, to prepare the way for adapting their electricity systems to the requirements of the Western European system. Data on the net imports of electricity in Central and Eastern European countries from 1990 to 1993 are presented in table 3.

Table 3. Net imports and exports of electricity in Central and Eastern Europe,[a] 1990-1993
(Terawatt hours)

	Year			
Party	1990	1991	1992	1993
Belarus	9.4	10.4	6.5	-24.4
Czech Republic	-0.7	-2.5	-3.0	-2.1
Estonia	-7.0	-4.8	-3.2	-1.6
Hungary	11.1	7.4	3.5	2.5
Latvia	3.6	4.2	4.1	2.5
Lithuania	-12.0	-12.8	-5.3	-2.7
Poland	-1.0	-2.6	-4.0	-2.4
Russian Federation	-4.5	-12.1	-16.2	6.0
Slovakia	5.2	4.3	3.7	2.0
Ukraine[b]	-28.3	-14.8	-5.1	-1.5

Source: International Energy Agency, *Energy Statistics for non-OECD countries*, Paris, 1995.

[a] Net imports are positive. Net exports are negative.
[b] Not a Party.

[9] International Energy Agency, *Electricity in European Economies in Transition*, Paris, 1994.

North America

13. Canada, Mexico and the United States trade electricity on a small scale with the United States being a net importer from both countries. In 1993, the United States imported approximately 1 per cent of its power from Canada and less than 0.1 per cent from Mexico.[10] Data on the export and import of electricity in North America in 1993 are presented in table 4.

Table 4. Bilateral electricity trade flows in North America, 1993[a]
(Terawatt hours)

	Exports to			
Exports from	Canada	Mexico	United States of America	Total
Canada	-	..	37.09	37.09
Mexico	..	-	1.99	1.99
United States of America	9.81	0.85	-	10.66
Total	9.81	0.85	39.08	49.74

Source: Energy Information Administration, United States Department of Energy, *Electric Power Annual 1994*, Volume II (Operational and Financial Data), tables 41 and 42 (November 1995).

[a] Values identify point of entry or exit, but do not necessarily identify point of consumption.

14. The United States electricity market is undergoing significant changes. The Federal Energy Regulatory Commission, which regulates power sales across State boundaries, has published a final rule which aims at rapidly introducing competition to the wholesale power market of the United States, but it is difficult to predict the impact that these changes will have on exports and imports.

2. The implications of electricity trading

15. The current trend to deregulate and liberalize the electricity industry in many countries and the possible increase in the extent of international electricity trading will have implications that are difficult to predict for greenhouse gas emissions, precursors of ozone

[10] Energy Information Administration, United States Department of Energy, *Electric Power Annual 1994*, Volume II (Operational and Financial Data), tables 41 and 42 (November 1995).

such as nitrogen oxides (NO_x) and other air pollutants, such as particulates and sulphur dioxide (SO_2).[11] The impacts will vary between regions and over time. One study of the United States market concludes that carbon dioxide (CO_2), NO_x, and SO_2 emissions will increase in the near term (two to twelve years) in part from a decrease in demand-side management [12] and investment in renewables, but mostly from the increased use of older, low variable cost, fossil fuel power plants and/or the premature closure of existing, expensive nuclear facilities.[13] Another study reaches similar conclusions, namely, that electricity restructuring in the United States is likely to have negative impacts on the environment, including increases in CO_2 emissions, because older, fossil fuel plants are likely to operate more often and longer than they would without restructuring.[14] These results may change for longer time periods and may not typify all regions, but many of the factors which will influence air pollution in the deregulated United States market will also affect deregulated markets in other regions, i.e. factors such as plant retirement age, plant utilization rate, the efficiency with which electricity is generated, fuel choice, and the rate of growth in the demand for electricity as prices change owing to competition.

16. Deregulation and any associated increase in electricity trading may, on the other hand, also create opportunities to reduce greenhouse gases in a more cost-effective manner than is currently possible. A study of Denmark, Norway and Sweden evaluated the effects of allowing countries to jointly accept one common emission reduction goal and to work together using electricity trading to reach that goal. The cost of reaching different goals was determined for scenarios which differ in the extent of electricity trade (no trade, trade limited to current transmission capacity, and unlimited trade) and in the extent of countries' ability to jointly implement emission reduction goals. The results indicate that jointly accepting one common emission reduction goal and trading in electricity could both significantly lower the cost of reducing emissions to Denmark, Norway and Sweden, compared to the costs if each country acted alone.[15]

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[11] Richard Rosen and others, *Promoting Environmental Quality in a Restructured Electric Industry*, prepared for the National Association of Regulatory Utility Commissioners (15 December 1995).

[12] Demand-side management refers to efforts to influence customers' demand for (purchase of) electricity. It usually consists of efforts to reduce this demand in order to decrease the need for new generation capacity.

[13] Henry Lee and Negeen Darani, *Electricity Trading and the Environment*, Environment and Natural Resources Program, Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University (22 November 1995).

[14] Richard Rosen and others, *loc. cit.*

[15] Tomas Larsson, "Benefits from electricity trade in northern Europe under CO_2 constraints," forthcoming in *Systems Modelling for Energy Policy*, Bunn and Larsen (eds.), John Wiley & Sons.

C. Options to account for the greenhouse gas emissions associated with electricity trade

17. The two basic ways to account for the emissions associated with the export or import of electricity are for either the exporting Party or the importing Party to do the accounting. However, an accurate estimate of the emissions associated with electricity imports only appears feasible on the basis of information obtained from the exporting Party regarding, for example, the actual sources or average sources of electricity. There does not appear to be an obvious basis for an option whereby the importing country can make a determination of the emissions by itself. Therefore, further consideration is given to just two options for the treatment of emissions associated with the import and export of electricity. They are:

(a) To require Parties that generate electricity to account for all emissions, even if the electricity is exported (referred to below as the generator option); and

(b) To require Parties that consume electricity to account for the emissions on the basis of information provided by, and in coordination with, the exporting Party (referred to below as the bilateral agreement option).

The generator option

18. Under this option Parties would include all emissions associated with electricity generation in their inventories, even if the electricity is exported. [16]

19. There are several advantages to the use of this option. First, the methodologies and data needed to calculate emissions associated with domestic electricity generation are currently available. Data on fuel consumption, the basis for this calculation, are collected in all Annex I countries, and the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories provide a method for estimating emissions. Secondly, this option does not require bilateral discussion of the quantity and nature of exports and imports.

20. The disadvantage of this option is that the consuming country does not have to account for the emissions associated with the electricity it utilizes. At the same time, a net exporting Party will have an increases in its national greenhouse gas emissions, if the electricity it exports is generated from fossil fuel. This would also need to be taken into account in its projections and has implications for the policies and measures for both Parties. For example, it may be more difficult for the net exporting Party to meet its emission limitation or reduction goal.

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[16] They would continue, however, to account for imports and exports of primary energy as discussed in the IPCC Guidelines for National Greenhouse Gas Inventories.

The bilateral agreement option

21. Under this option, a Party would increase its national emission inventory if it imports electricity produced by fossil fuel combustion, and decrease its national inventory if it exports electricity produced from fossil fuels. The quantity of emissions would be determined on the basis of information shared by the Parties, either informally or through formal agreements between them. Both Parties would need to alter their emission forecasts, if long-term contracts are negotiated.

22. There are several advantages to this option. The first is that the consuming country has the primary responsibility to account for the emissions associated with the electricity it imports. A second advantage is that it provides a mechanism for Parties which decide to jointly implement common emission reduction goals, using electricity trade, to do so in a transparent manner.

23. There are also several disadvantages to the bilateral agreement option. First, to apply this option, Parties would need to exchange the necessary data, compare calculations, and ensure that they are in agreement on adjustments to their national inventories. Secondly, there is no methodology currently available for use by Parties exporting or importing electricity to estimate the emissions in another country. With regard to this issue two approaches are possible. Countries could choose to use any mutually acceptable approach, providing they identify the procedure in their respective national inventories. Alternatively, a general methodology could be developed to be agreed by the Conference of the Parties. Regardless of what approach is taken, Parties will need to address the following types of questions:

(a) How should the emissions associated with electricity trade be calculated?

(b) What data are necessary to make this calculation?

(c) Are such data already available? If not, how should they be collected?

(d) Should calculations be completed for every trade, monthly for all trades, annually for all trades, or otherwise?

(e) How should the emissions associated with electricity lost during transmission be calculated and allocated between trading Parties?

(f) How should emissions based on electricity trades between more than two Parties be estimated?

(g) Should projections include estimates of future electricity trades?

24. The question of how the emissions associated with electricity trade should be calculated may not be easy to answer. In some cases, Parties may wish to base the calculation on the actual source. In other cases, they may prefer average sources. [17] The use of emissions associated with the average of sources, however, may lead to a situation where the emissions associated with traded electricity are under- or over-counted. For example, in a situation where the average sources are used to calculate the emissions, but where the baseload is nuclear and the marginal source uses fossil fuel, the emissions associated with the exported electricity would be underestimated. However, provided both countries agreed on the quantity, the total emissions reported by both countries should not be affected.

III. EMISSIONS FROM INTERNATIONAL BUNKER FUELS

A. Introduction

25. The primary purpose of this section is to provide detailed information on the scope and possible options for allocating and controlling emissions associated with international aviation and marine bunkers.[18] The general background, possible action by the SBSTA and a preliminary discussion of options may be found in document FCCC/SBSTA/1996/9/Add.1.

B. Background information on the aviation industry

The aviation sector

26. Air traffic is customarily divided into three categories: civil aviation, comprising aircraft used for the commercial transport of passengers and freight; military aviation, comprising aircraft under the control of national armed forces; and light aviation, comprising recreational and small corporate aircraft. As used in this paper, bunker fuel emissions are exclusively related to civil aviation, which is by far the largest of these three categories. There are some 150 to 200 airline companies that operate international flights.

27. At present, there is generally a strong connection between airlines and countries, for instance in the case of national carriers. However, given the trend towards privatization and the merging of airlines, this connection may not be maintained. With regard to aircraft, many are registered in countries for economic reasons, but may actually be leased or chartered for operation elsewhere.

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[17] It should be recognized that the production of electricity from a new power plant can affect the entire grid. Some sources may be taken off line and others added. In a few instances these secondary effects may need to be considered.

[18] For the purpose of this paper, international bunker fuels are defined as fuels sold to any air or marine vessel engaged in international transport.

28. The great majority of aircraft are subsonic, that is, they fly at less than the speed of sound, although there are 13 civilian supersonic aircraft in service. By far the most commonly used type of fuel is aviation kerosene. There are no internationally agreed specifications for this fuel, but national and industry specifications ensure its quality and uniformity worldwide. Globally, there are about 70 to 100 producers of aviation fuel.

29. The fuel intake of an aircraft does not necessarily take place in the country of departure. Since carrying excess fuel increases the weight of the aircraft and hence the amount of fuel required to reach the next airport, aircraft on long-haul flights usually only take on the amount of fuel required to reach the next airport. On shorter flights, aircraft may carry sufficient fuel for several stops, depending upon fuel prices and other considerations.

30. The amount of fuel oil uplifted by civilian air carriers registered in a country and the amount of fuel uplifted by all civilian air carriers in that country are shown in table 5.

Table 5. Estimates of fuel by uplifted by civilian air carriers, 1993
(millions of tons)

Country	Fuel uplifted by carriers registered in a country	Fuel uplifted by all carriers in a country
Australia	2.08	1.66
Brazil	1.14	1.10
Canada	1.51	1.72
France	3.10	3.06
Germany	4.02	3.96
Italy	1.56	1.49
Japan	4.06	5.30
Netherlands	2.40	2.07
New Zealand	1.14	0.78
Republic of Korea	1.79	1.30
Russian Federation	3.30	1.72
Singapore	2.20	1.87
Spain	1.13	1.12
Switzerland	1.29	1.20
Thailand	1.08	1.96
United Arab Emirates	0.30	1.38
United Kingdom	6.66	7.04
United States of America	14.41	14.52

Note: The data in this table were provided by ICAO on the basis of its scheduled airline production database. They do not include non-scheduled, private or military operations. Some flights may be double counted. Sector fuel quantities have been calculated by ICAO on the basis of the scheduled flight time, using data for each aircraft type supplied by the aircraft manufacturers. No use of fuel for holding or diversion is assumed.

31. The production of civilian aircraft and engines is limited to a small number of large companies, which respond to the demand by airlines for aircraft with different attributes. In this regard, the industry is unique in so far as the number of major manufacturers is very small.

Greenhouse gases in the aviation sector

32. The greenhouse gases emitted from aircraft are carbon dioxide (CO_2) and water vapour (H_2O), and the precursors carbon monoxide (CO), nitrogen oxides (NO_x) and volatile organic compounds (VOC).

33. The combustion of one kilogram of fuel produces 3,155 grams of CO_2 and 1,237 grams of water vapour, with small variations depending on the composition of the fuel. The quantity of SO_x exhaust depends entirely on the sulphur content of the fuel. The emissions of NO_x, CO and VOCs per kilogram of combusted fuel are known within certain ranges. However, these strongly depend on the jet engine, the characteristics of the specific flight, the phase of the flight and on the type of fuel. The majority of NO_x emissions occur during cruise flight, but it is difficult to measure emissions directly under those conditions. CO and VOCs are the products of incomplete combustion, and their emissions occur mainly during landing and take-off because engines are then operating at reduced power settings.

34. CO_2 and NO_x are considered to be the main contributors to the greenhouse effect from air traffic emissions. The IPCC estimated in *Climate Change 1994* that the indirect effect of aircraft NO_x emissions is roughly the same as the direct effect of aircraft CO_2 emissions. At the cruising altitudes of subsonic aircraft the NO_x emissions contribute to the formation of ozone. At those altitudes, the greenhouse effect of ozone is at its strongest.

35. The impact of NO_x depends on the altitude of the actual emission. The cruising altitude of supersonic aircraft, near or in the ozone layer, is higher than that of subsonic aircraft. At that altitude NO_x emissions contribute to ozone depletion.

Magnitude of greenhouse gas emissions from aviation

36. The emissions from international aviation as reported by the Annex I Parties for 1990 are presented in annex I. Only seven Parties reported separate data on emissions from aviation bunkers. In addition, for comparative purposes the secretariat used IEA data, based on deliveries of aviation fuels, to estimate the CO_2 emissions for 1992 presented in annex II. The year 1992 was utilized because the data cover also countries with economies in transition and because for 1990 the IEA did not differentiate between international and other aviation bunkers. While the data for CO_2 in the two annexes are largely similar, many are different. This suggests a need for further efforts to improve the quality of data reported to different institutions.

37. In addition to IEA, other institutions such as the United Nations, EUROSTAT and ICAO collect fuel data. Each of these sources has different methodologies and categories which have changed with time. The data obtained by the United Nations and the IEA are aggregated at national level, which means that information concerning the different aviation companies and fuel suppliers is lost. On the other hand, EUROSTAT has these data available, but only for European countries. Differences in data from various sources would need to be considered by Parties in any determination of whether to allocate emissions retroactively or to establish a future date for their allocation.

38. The total amount of fuel used for international civil aviation is estimated to be about 138 Mt, representing 435 Mt CO_2.[19] The IPCC (1994) estimates that global emissions from all sources in 1990 amounted to about 26,000 Mt CO_2. This suggests that international aviation accounted for about 2 per cent of global CO_2 emissions from all sources in 1990.

Factors likely to affect future aviation emissions

39. The Committee on Aviation Environmental Protection of ICAO has predicted that air traffic will grow at an annual rate of 5 per cent for the foreseeable future. The growth rate of emissions may be somewhat less because of the following:

(a) Changes in aircraft engines, for example, 'propfan'[20] engines may be introduced after the year 2000 and could increase efficiency by 20 per cent. Also, improvements in the combustion process, for example through the use of staged combustion, could reduce NO_x emissions compared with present engine emission levels. New engines that utilize more advanced technology might be introduced after 2010 and this may lead to lower emissions from engines of equivalent power;

(b) Improvements to aircraft frames, for example, by reducing drag and introducing lighter materials;

(c) Increases in the size of aircraft, which may offer emission benefits because they would use less fuel per passenger-kilometre;

(d) Implementation of operational measures, for example, by:

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[19] Balashov and Smith, "ICAO analyses trends in fuel consumption by world's airlines", *ICAO Journal*, August 1992.

[20] J.A. Peper and H.B.G. ten Have, *Inventory of Air Pollution from Civil Aviation in Dutch Airspace in 1992*, NLR Report CR 94413 L, 1994. National Aerospace Laboratory, Amsterdam.

(i) Lowering cruising altitudes, reducing cruising speeds or changing flight routes;

(ii) Improving the efficiency of air traffic control systems;

(iii) Modifying the distribution of airspace (especially between civil and military aircraft) and allowing the airspace to be managed in a flexible manner; and

(iv) Changing the landing and take-off cycle in and around airports.

(e) Changes in policies relating, for example, to taxes and subsidies for the airline industry and/or competing modes of transportation.

The role of international bodies

40. ICAO was established by the Convention on International Civil Aviation (1944) and became one of the specialized agencies of the United Nations. One hundred and eighty-three Parties signed the Convention, making it the fundamental treaty governing international civil aviation. Bilateral air service agreements which regulate relations between individual States are based on the Convention.

41. In 1981, ICAO established standards for the control of aircraft emissions through an engine certification scheme. These standards, which are included in annex 16 (volume II) to the Convention on International Civil Aviation, establish limits for three pollutants (NO_x, CO and HC) from new engines. ICAO keeps the standards under review. In March 1993, for example, the ICAO Council agreed to reduce the permitted amounts of NO_x by 20 per cent. A committee of experts, the Committee on Aviation Environmental Protection, is charged with making recommendations regarding environmental policy to the decision-making bodies of ICAO.

C. Allocation options and control of emissions from international aviation bunkers

42. A preliminary discussion of allocation options which takes into account the characteristics of the aviation industry and the factors mentioned in document FCCC/SBSTA/1996/9/Add.1 is given below. Considerations to be borne in mind in this connection are: the data required to implement different options; the need for methodologies; and the relationship of the options to possible policies and measures, such as taxes, standards and voluntary agreements.

Option 1 No allocation

43. This option represents the status quo, that is reporting of emissions by Parties in a separate category. In the case of no allocation, the emissions from international aviation would still need to be considered in relation to Article 4.2 of the Convention. In that case, ICAO may be able to be of assistance. However, Parties would need to consider the extent to which emissions could and should be controlled, and perhaps the approach, for example, voluntary measures, taxes, or standards. The attribution of the final responsibility for the control of international emissions would also have to be considered in lieu of ICAO because ICAO is not a Party.

Option 2 Allocation of global emissions from bunker fuels to Parties in proportion to their national emissions

44. This option would allocate emissions in proportion to the contribution of a Party to global emissions. For example, the 1990 share of global international aviation was about 2 per cent of the global CO_2 emissions from all sources. With proportional allocation, each Party would add about 2 per cent to its domestic emissions in order to cover all international emissions jointly. Other allocation methods could lead to higher allocations for some Parties, and lower allocations for others.

45. This option acknowledges the international character of international emissions, while still allocating them. It may create an incentive for international control measures and it leaves the basis for control open, since it does not relate emissions to an activity such as bunker fuel sales or aircraft or passenger movements.

Option 3 Allocation to Parties according to the country where the bunker fuel is sold

46. This option would allocate emissions to Annex I Parties on the basis of aviation fuel sales based on data similar to those contained in table 5. Eventually, it may be possible, with the cooperation of the airline industry, to break emissions down further on the basis of aircraft type. The option appears to have a precedent, namely in the allocation of emissions from fuel use in road transport, since fuel may be sold in one country and emissions may occur in another, although road transport differs with regard to the number of vehicles and decision-making processes.

47. With regard to its effect on possible controls, the option would provide little incentive to apply national standards for aircraft as these could create inequities among countries. Other measures such as taxes might apply, but since an aircraft could take on extra fuel elsewhere or change its flight routes to avoid taxes or levies, such a measure might need consideration at international level.

Option 4 Allocation to Parties according to the nationality of the transporting company, the country where the aircraft is registered, or the country of the operator

48. This set of three options has the common feature that the owner/operator relationship is a primary determinant for allocation. The first case has the advantage that national airlines typically maintain information on the amount of fuel they have uplifted that could be made available to Parties. This may be a more complex process for the case of aircraft registered in one country, but owned and operated in another country. Similar figures based on fuel uptake (instead of consumption) by any operator would require a greater breakdown of figures.

49. An advantage of this option is that the country of the owner/operator may be in a good position to require its owner/operators to reduce their world-wide fuel usage, for instance by setting standards or charging taxes and levies. However, measures linked to owner/operators may create inequities among Parties, unless there is an international agreement. In any case, identifying the link between airlines, aircraft and countries may become more complicated if airlines change the country where they are based, merge, or change leasing arrangements.

Option 5* Allocation to Parties according to the country of departure or destination of an aircraft or vessel. Alternatively the emissions related to the journey of an aircraft or vessel could be shared between the country of departure and the country of arrival

50. This option would require sharing information between Parties. It might be feasible, in particular for long flights, but it would be much more complex for short flights, in so far as it would require breaking fuel intake or consumption down by country of departure and destination. Nevertheless, if aircraft movements could be broken down by aircraft types, this allocation option could account for differences in emissions between various aircraft. It could even account for differences in emissions which are related to cruising altitudes and routes. Methodologies for calculating emissions, on this basis are not available and would need to be developed.

51. As in the case of option 3, standards for aircraft and engine design could help control emissions, but there would be few incentives for national standards as these could create inequities among countries. Also, as in the previous option, any consideration of taxes as a control may be more effective if done at international level.

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* Options considered to be less practical because of data requirements or inadequate global coverage.

Option 6* Allocation to Parties according to the country of departure or destination of passenger or cargo. Alternatively, the emissions related to the journey of a passenger or cargo could be shared by the country of depa ture and the country of arrival

52. This option would require Parties to compile information based on the destination of the cargo and passengers. The statistics would have to be cross-referenced to fuel use. While conceptually possible, at the present time there is no system to acquire the data or methodology to calculate the emissions. Acquiring the detailed information would also involve additional administration and some extra cost.

Option 7* Allocation to Parties according to the country of origin of the passenger or owner of the cargo

53. This option requires the same statistics as option 5, but would have to be cross-referenced with data on the country of origin of the passenger and owner of the cargo. This higher level of detail would involve additional administration and could be costly. There is no methodology for calculating emissions and no precedent for this approach among existing IPCC methodologies.

Option 8* Allocation to the Party of emissions generated its national space

54. This option has a precedent in other sectors, where emissions are allocated to the Party where the emissions occur in accordance with the IPCC Guidelines. In the case of aviation, it would require cross-referencing between fuel consumption and flight route. A correlation with aircraft type would lead to more accuracy.

55. However, this option would not lead to full coverage of emissions from international aviation, many of which occur above international waters. It is therefore not seen as a feasible option.

D. Background information on the marine industry

The marine transport sector

56. The marine shipping industry is currently composed of approximately 82,000 vessels with a gross tonnage of 491 million tons, excluding vessels under 100 gross tons. It is characterized by complex relationships. A ship can be owned by a company in one country, which itself is owned by other companies in other countries, registered in another, operated by a ship-management company in a third country and crewed from a manning agency in a

* Options considered to be less practical because of data requirements or inadequate global coverage.

fourth country with nationals from yet other countries. Furthermore, carriage can be paid for by charterers, and in some cases a number of sub-charterers, based in other countries. Table 6 provides data on the major countries of registration and table 7 on the major countries of ownership of the world is cargo fleet.

Table 6. World cargo fleet by country of registration, 1995[21]
(Percentage)

Country/territory of registration	Share of vessels	Share of deadweight tonnage
Panama	10.3	15.0
Liberia*	3.6	13.5
Greece	3.6	7.2
Cyprus*	3.6	5.6
Bahamas	2.4	5.0
Norway	1.5	4.2
Malta	2.5	4.1
Japan	12.6	3.9
China	4.8	3.4
Singapore*	1.9	2.9
United States of America	1.1	2.3
Hong Kong*	0.8	2.1
Philippines	2.4	1.9
Russian Federation	4.5	1.8
India	1.0	1.6
Turkey*	2.2	1.4
Republic of Korea	1.8	1.4
St. Vincent and the Grenadines*	1.8	1.3
Italy	1.8	1.2

* Not a Party.

[21] Lloyd's Register of Shipping, *Lloyd's Fleet Statistics, December 1992*, London, 1993, as updated by Lloyd's Register of Shipping.

Table 7. World cargo fleet by country of ownership, 1992[22]
(Percentage)

Country/territory of ownership	Share of vessels	Share of deadweight tonnage
Greece	8.0	14.8
Japan	18.0	13.3
United States	2.9	8.7
Norway	4.8	7.9
Hong Kong*	2.1	4.6
China	4.5	4.0
United Kingdom of Great Britain and Northern Ireland	2.4	3.5
Russian Federation	4.8	2.8
Republic of Korea	2.3	2.7
Germany	4.0	2.5
Denmark	2.0	1.9
weden	1.4	1.8
Italy	2.4	1.7
India	1.1	1.6
Brazil	0.8	1.5
Singapore*	1.7	1.3
Iran*	0.5	1.2
Turkey*	2.0	1.1
France	0.8	1.0

* Not a Party.

57. Two types of marine fuel, gas oil and fuel oil, are used almost exclusively for propulsion, because of their relatively low cost and ease of handling. It is estimated that in 1990, 40 million tons of gas oil and 100 million tons of fuel oil were consumed for this purpose.[23] Marine fuels are not necessarily loaded at the outset of a voyage but rather they may be loaded at any convenient time in the ship's operating schedule. Fuel costs can

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[22] Lloyd's Register of Shipping, *Lloyd's Fleet Statistics, December 1992*, London, 1993, as updated based on present communication.

[23] Liddy, J.P., *Bunker Fuels - A Global View towards Year 2000*, Norwegian Shipping Academy, Oslo, 1992.

represent a substantial part of a ship's operating costs, in excess of 50 per cent in some cases, so the market is particularly price-sensitive. Oil prices vary considerably from port to port, and even within a port, and with time. The quantity of fuel loaded depends among other aspects, on the size of the ship and the trade in which it is involved. Oil fuels are rarely purchased direct from the manufacturer (the refinery). Instead, a range of oil traders, brokers and suppliers act as intermediaries. Table 8 provides a list of the principal countries and territories supplying international marine fuels. Collectively, these account for nearly 91 per cent of the fuel oil and 84 per cent of the gas oil supplied as international marine bunkers by countries reporting data to the United Nations.

Table 8. **Principal countries/territories supplying international marine bunker fuels: shares of total world supplies, 1993**
(Percentage)

Country/territory	Fuel oil	Country/territory	Gas oil
United States	21.0	Saudi Arabia	20.3
Netherlands	12.3	Netherlands	9.8
Singapore*	10.4	United States	9.4
Japan	7.9	United Kingdom	6.0
Saudi Arabia	6.4	Singapore*	4.4
Belgium	4.5	Spain	3.9
South Korea	4.2	Greece	3.7
Spain	3.4	Belgium	3.4
Greece	2.9	Italy	2.9
France	2.7	Germany	2.6
Italy	2.3	Republic of Korea	2.3
Germany	2.1	Hong Kong*	2.3
Hong Kong*	1.6	Japan	2.0
United Kingdom	1.6	Egypt	1.8
Egypt	1.5	France	1.5
Denmark	1.1	Argentina	1.3
Brazil	1.0	Angola*	1.3
Gibraltar*	1.0	Norway	1.2
Sweden	1.0	Denmark	2.3

Source: United Nations, *Energy Statistics Yearbook 1993*, United Nations, New York, 1995.

* Not a Party.

58. The diesel engine is the predominant form of power unit used in the marine industry because of its relatively high fuel efficiency, which is typically around 45 per cent. Power requirements are dictated by various ship characteristics and circumstances. Speed, for

example, is very significant due to the cube law relationship between oil fuel consumption and speed; an increase in speed of 25 per cent can result in a doubling of oil fuel consumption. However, the shipping industry's energy consumption, in terms of deadweight ton-kilometres per unit of energy, is relatively low compared to other modes of transport.

59. In terms of function, the principal division of the marine industry is between cargo-carrying vessels and ships engaged in miscellaneous activity. Cargo-carrying ships comprise bulk liquid, bulk dry cargo, passenger and other dry cargo vessels. The heading 'miscellaneous' covers fishing, offshore and harbour support services. Nearly 59 per cent of the cargo vessels are of less than 5,000 deadweight tons (dwt). They account for just over 5 per cent of total tonnage, while 1,339 vessels (3 per cent by number) are of greater than 100,000 dwt, representing 36 per cent of deadweight tonnage.

Greenhouse gases in the marine sector

60. The greenhouse gases emitted from the marine sector are carbon dioxide (CO_2) and water vapour (H_2O), and the precursors carbon monoxide (CO), nitrogen oxides (NO_x) and volatile organic compounds (VOC). The marine sector is also a source of SO_2 emissions.

61. The combustion of one kilogram of marine bunker fuel produces about 3,150 grams of CO_2 and 1,000 grams of water vapour, with small variations. The amount of SO_x exhaust depends on the fuel's sulphur content. NO_x formation is primarily dependent on extreme temperatures and consequently a feature of highly charged, and hence, highly fuel-efficient, diesel engines. CO and VOC emissions are the result of incomplete combustion, and their levels are minor in comparison to CO_2 emissions.

62. CO_2 is the main greenhouse gas resulting from marine shipping. In comparison to aviation, the global warming impact of NO_x emissions from shipping is relatively small since the emissions are at ground level. However, there is interest in reducing NO_x emissions because they contribute to acidification and ground level ozone.

Magnitude of greenhouse gas marine emissions from shipping

63. The emissions from the marine shipping industry as reported by Parties in their national communications are presented in annex I. Seven Parties reported emissions for the marine bunkers. In addition, as in the case of aviation bunkers, for comparative purposes the secretariat used IEA data, based on deliveries of marine fuels, for 1992 to estimate CO_2 emissions as presented in annex II.

64. Data on international marine bunkering are also gathered by organizations other than the IEA, such as the United Nations and Lloyd's Register of Shipping. According to United Nations statistics[24], aggregate fuel sales worldwide amounted to nearly 100 Mt in 1990 although data for some countries, for example, China and the Russian Federation, are omitted. Other sources[25] which include all countries, suggest a higher figure of 150 Mt, representing about 2 per cent of global emissions from all sources.

The role of international bodies

65. Most international marine regulations are drawn up by IMO, which is a technical organization of the United Nations. IMO develops international codes, recommendations and conventions, one of which is the International Convention for the Prevention of Pollution from Ships (MARPOL). The IMO conventions do not have the force of law, since this remains the prerogative of the member States. However, the most important IMO conventions are widely accepted by member States, which account for around 98 per cent of the world tonnage. An annex to MARPOL on air pollution is currently being considered, to phase out the use of ozone-depleting refrigerants, control the use of incinerators, and limit emissions of SO_x and NO_x. The annex will be discussed at the IMO Assembly to be held in March 1997.

E. Allocation options and control of emissions from international marine bunkers

66. A preliminary discussion of allocation options which takes into account the characteristics of the shipping industry and the factors mentioned in document FCCC/SBSTA/1996/9/Add.1 is given below. Considerations to be borne in mind in this connection are: the data required to implement different options; the need for methodologies; and the relationship of the options to possible policies and measures, such as taxes, standards and voluntary agreements.

Option 1 No allocation

67. As in the case of aviation bunkers, this option represents the status quo, that is reporting of emissions by Parties in a separate category. In the case of no allocation, the emissions from international marine bunkers would still need to be considered in relation to Article 4.2 of the Convention. In that case, IMO may be able to be of assistance. However, Parties would need to consider the extent to which emissions could and should be controlled,

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[24] United Nations, *Energy Statistics Yearbook 1993*, United Nations, New York, 1995.

[25] Oil Companies European Organization for Environmental and Health Protection (CONCAWE), *European Environmental and Refining Implications of Reducing the Sulphur Content of Marine Bunker Fuels*, CONCAWE, The Hague, 1993.

and perhaps the approach, for example, voluntary measures, taxes, or standards. The attribution of the final responsibility for the control of international emissions would also have to be considered in lieu of IMO, because IMO is not a Party.

Option 2 Allocation to Parties in proportion to their national emissions

68. This option would allocate emissions in proportion to the contribution of a Party to global emissions. For example, international marine bunkers contributed about 2 per cent of the global emissions from all sources in 1990. With proportional allocation, each Party would add about 2 per cent to its domestic emissions inventory, in order to cover all international emissions jointly. This option may, however, distort the emissions inventories of some countries for example, land-locked countries or small countries with sizeable sea ports. Other allocation methods could lead to higher allocations for some Parties and lower allocations for others.

69. This option acknowledges the international character of marine bunker emissions, while still allocating them. It may create an incentive for international control measures, and leaves the basis for control open, since it does not relate emissions to an activity such as bunker fuel sales or ship movements.

Option 3 Allocation to Parties according to the country where the bunker fuel is sold.

70. This option would allocate emissions to Parties on the basis of marine fuel sales for which data are generally available. The option appears to have a precedent, namely in the allocation of emissions from fuel use in road transport, since fuel may be sold in one country and the emissions may occur in another, although the number of vehicles and decision-making processes are different.

71. With regard to its effect on possible controls, the option would provide little room for affecting emissions through national policies and measures. For example, a Party could not significantly influence vessel emissions through national standards. Other measures such as taxes might not be effective, since a ship could take on extra fuel elsewhere to avoid taxes or levies. Such a measure might need consideration at international level.

Option 4 Allocation to Parties according to the nationality of the transporting company, or to the country where the vessel is registered, or to the country of the operator

72. This set of three cases has the common feature that the owner/operator relationship is a primary determinant for allocation. In the first case, it would be necessary for each Party in which ship-owning companies are based, to collect annual data on oil consumption. Also, some countries such as Japan, the United States of America and the United Kingdom of Great Britain and Northern Ireland export and import large quantities of materials by sea in ships registered, owned and/or operated by other countries. Others such as Greece and Norway,

are rarely visited by ships of the country of registration or ownership, since these are engaged in cross trading. Consequently, the allocation of emissions to these countries may not accurately reflect the economic benefits derived from the vessel. Data collection systems would have to be improved or developed by some Parties.

73. In the second case, allocation by country of registration, the basis for estimating oil fuel consumption could be a ship's oil record book which is a logbook required under the provisions of MARPOL Annex I. Under this regulation, it is necessary for all fuel deliveries to be logged and reported to the country of registration. This option is attractive because the country of registration already collects a certain amount of data on each of the ships under its jurisdiction, if only for the purposes of assessing fees. However, while many of the countries listed in table 6 derive some benefits from the ships under their registration, they often have little direct responsibility for their operations. Information collection systems may also vary among countries and would need to be improved.

74. In the third case, allocation by country of the operator, a mechanism for data collection is much removed, as is the principal responsibility for maintenance and financial operations. This appears to be an important limitation.

75. With regard to the relationship to control options, only the first case appears to offer the possibility of providing incentives and mechanisms for national policies to affect emissions. As in other cases, the effectiveness of national action would appear to be limited.

Option 5* Allocation to Parties according to the country of departure or destination of a vessel. Alternatively the emissions related to the journey of a vessel could be shared between the country of departure and the country of arrival

76. This option would require sharing information between Parties. It might be feasible for long voyages, but it would be much more complex for ships making multiple short stops. It would require breaking fuel intake or consumption down by country of departure and destination. Also, it would not take into consideration the speed of a ship or other operational characteristics. Methodologies for calculating emissions, on this basis are not available and would need to be developed. As in option 3, there would appear to be little room for affecting emissions through national policies and measures.

Option 6* Allocation to Parties according to the country of departure or destination of passenger or cargo. Alternatively, the emissions related to the journey of a passenger or cargo could be shared by the country of departure and the country of arrival

77. This option would require Parties to compile information on the destination of cargo and passengers. The statistics would have to be correlated to fuel use. While conceptually possible, at the present time there is no system to acquire the data or methodology to

calculate the emissions. Acquiring the detailed information would involve additional administration and some extra cost.

Option 7* Allocation to Parties according to the country of that owns the cargo or origin of the passenger

78. This option requires the same statistics as option 5, but would have to be supplemented with data on the country of origin of passengers and owner of cargoes. Moreover, the owner of a cargo may change during transport, adding further complexity. This higher level of detail would involve additional administration and could be costly. There is no methodology for calculating emissions and no precedent among existing IPCC methods for the approach.

Option 8* Allocation to the Party of emissions generated in its national space

79. As in the case of aviation, this option has a precedent in other sectors where emissions are allocated to the Party where they occur as per the IPCC Guidelines. In the case of the marine industry, it would require correlation of fuel consumption and voyage routes. A breakdown by vessel type would lead to more accuracy. However, this option would not lead to full global coverage of emissions from international marine bunkers, many of which occur in international waters. It is therefore not seen as a feasible option.

* Options considered to be less practical because of data requirements or inadequate global coverage.

Annex I

Anthropogenic emissions of precursors from international bunkers by Annex I Parties, 1990 (*Gigagrams*)

	CO			NO_x			NMVOC			CO_2		
	Aviation	Marine	Total	Aviation	Marine	Total	Aviation	Marine	Total	Aviation	Marine	Total
Australia	3.1	3.6	6.8	16.3	54.4	70.8	0.2	2.0	2.2	4 228.0	2 053.0	6 281.0
Austria	..	..	..	..	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	..	..	..	..	..
Bulgaria	..	..	..	..	..	..	..	..	..	..	..	..
Canada	12.3	25.5	37.8	4.7	13.0	17.7	1.9	8.8	10.7	3 614.0	2 066.0	5 680.0
Czech Republic	..	..	..	..	..	..	..	..	..	..	..	..
Denmark	0.7	16.6	17.3	5.1	66.1	71.1	0.2	2.5	2.7	1 915.0	3 059.0	4 975.0
Estonia	..	..	..	..	..	..	..	..	..	..	..	..
Finland	..	..	..	..	..	22.0	..	..	..	..	..	2 800.0
France	..	..	20.8	..	..	110.5	..	..	5.3	..	..	8 586.0
Germany	58.0	38.0	96.0	51.0	155.0	206.0	..	..	26.0	..	..	19 569.0
Greece	..	..	..	..	..	..	..	..	..	..	..	11 730.0
Hungary	..	..	..	..	..	..	..	..	..	..	..	..
Iceland	..	..	1.1	..	..	2.5	..	..	0.2	..	..	294.0
Ireland	..	..	2.1	..	..	5.3	..	..	0.3	..	..	1 172.0
Italy	18.0	5.1	23.2	15.5	234.4	250.0	1.2	..	1.2	3 956.0	8 494.0	12 450.0
Japan	..	..	..	..	..	..	..	..	..	..	..	31 000.0
Latvia	..	..	..	..	..	..	..	..	..	..	..	..
Liechtenstein	..	..	..	..	..	..	..	..	..	..	..	..
Luxembourg	..	..	..	..	..	..	..	..	..	..	..	..
Monaco	..	..	..	..	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..	..	4 500.0	35 900.0	40 600.0
New Zealand	..	..	5.5	..	..	26.9	..	..	..	..	..	2 413.0
Norway	0.6	2.3	2.9	0.7	32.1	32.8	0.1	1.1	1.2	300.0	1 500.0	1 800.0
Poland	..	..	..	..	..	..	..	..	..	..	..	..
Portugal	..	..	2 43.2	..	..	43.0	..	..	32.2	..	..	3 938.0
Romania	..	..	..	..	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..	..	..	..	..
Slovakia	..	..	..	..	..	..	..	..	..	..	..	..
Spain	9.8	7.1	17.0	23.6	248.2	271.8	0.1	11.2	11.4	5 948.0	12 076.0	18 024.0
Sweden	..	..	44.0	..	..	60.0	..	..	15.0	..	..	4 190.0
Switzerland	..	..	..	..	..	..	..	..	..	..	..	2 160.0
United Kingdom	26.9	249.5	3.4	..	..	..	..	..	..	..	..	20 729.0
United States	..	..		..	..	..	..	..	..	..	..	82 942.0
Total						1 440.1			111.9			281 334.0

Source: Based on data submitted in national communications.

Annex II

Anthropogenic emissions of CO_2 from international bunkers by Annex I Parties, 1992
(Gigagrams)

	Aviation	Marine	Total*
Australia	4 721	1 653	6 374
Austria	621	..	621
Belgium	2 843	12 290	15 133
Bulgaria	879	787	1 666
Canada	3 319	1 702	5 021
Czech Republic	730	..	730
Denmark	1 847	2 687	4 534
Estonia	37	..	37
Finland	835	2 007	2 842
France	10 448	7 405	17 854
Germany	15 082	5 102	20 184
Greece	2 203	7 842	10 046
Hungary	410	..	410
Iceland	230	..	230
Ireland	930	46	976
Italy	7 284	7 093	14 378
Japan	14 231	16 607	30 838
Latvia	279	..	279
Liechtenstein	..	..	..
Luxembourg	407	..	407
Monaco	..	..	..
Netherlands	5 875	33 120	38 995
New Zealand	1 321	796	2 117
Norway	252	1 445	1 697
Poland	731	849	1 580
Portugal	1 664	1 795	3 459
Romania	557	..	557
Russian Federation	43 941	..	43 941
Slovakia	125	..	125
Spain	3 562	11 631	15 192
Sweden	1 034	2 650	3 684
Switzerland	3 190	52	3 242
United Kingdom	12 043	7 508	19 552
United States	..	90 117	90 117
Total	141 631	215 184	356 815

Source: Based on IEA Energy Statistics. Data were extracted from the EDGAR database at the RIVM in the Netherlands and processed by the secretariat.

* Does not in all cases reflect both aviation and marine data.